LIVERMORE LAB REPORT

A weekly review of scientific and technological achievements from Lawrence Livermore National Laboratory, Dec. Dec. 16-20, 2013.

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TAKE THAT CO2 RIGHT OUT OF THE AIR

The Krafla geothermal power plant in Iceland. Lawrence Livermore researchers are developing a new geothermal power plant that will lock away carbon dioxide. Image courtesy of Ásgeir Eggertson.

Researchers are developing a new kind of geothermal power plant that will lock away unwanted carbon dioxide (CO_2) underground and use it as a tool to boost electric power generation by at least 10 times compared to conventional geothermal power.

The technology for this design already exists in different industries, and the researchers, led by Tom Buscheck, earth scientist from Lawrence Livermore, are hopeful their new approach to the technology will expand the use of geothermal energy in the U.S. far beyond the small handful of states that can take advantage of it now. Heat Mining Company, LLC, a startup spun off from the University of Minnesota, expects to have an operational project based on an earlier form of this new approach in 2016.

At the American Geophysical Union meeting recently in San Francisco, Buscheck and his colleagues from The Ohio State University, the University of Minnesota and LLNL, debuted an expanded version of the design and explained the role that this new approach to geothermal energy production and grid-scale energy storage can have in addressing climate change.

To read more, go to *Red Orbit*.

SCIENTIFIC AMERICAN™

RECORDING THE OCEAN'S HISTORY

Living and fossilized coral gathered from dives in the Hawaiian Islands are used by a Lawrence Livermore scientist and collaborators to study whether a long-term shift in nitrogen content in the Pacific Ocean has occurred as a result of climate change. Image courtesy of NOAA Hawaii Undersea Research Laboratory.

In the deep subtropical Pacific, one of the world's longest-lived animals has been recording the ocean's history.

The Hawaiian gold coral which lives in treelike colonies about 1,300 feet below the ocean's surface, has been dated to be up to 3,000 years old.

Scientists including Lawrence Livermore's Tom Guilderson are using some of these ancient animals to prove that changes in ocean chemistry are linked with changes in the climate.

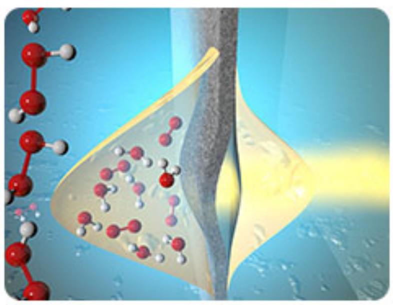
It turns out there is a very distinct change in the nitrogen content in the corals over the last 150 years that coincides with two major things. One is the end of the Little Ice Age, and the other is the beginning of the Industrial Revolution.

However, Guilderson and his colleagues were careful to note their research is unable to distinguish between whether the changes are due to natural climate changes, such as the Earth's exit from the Little Ice Age, or human-caused warming. "We can't answer that question," Guilderson said.

To read more, go *Scientific American*.

SCIENCE CODEX

A SMASHING GOOD TIME



A schematic representation of the shock experiment. The resulting energy release pushed the shock front to the left. Image by Liam Krauss/LLNL.

Lawrence Livermore researchers have discovered how explosives respond to shock waves.

They combined ultra-fast time-resolved experimental measurements with theory to reveal how an explosive responds to a high-impact shock. The work involved advances in both ultra-fast experimental shock wave methods and molecular dynamics (MD) simulation techniques, and the combination of experiment and simulation is a milestone in understanding chemical initiation and detonation.

When an energetic material is hit hard and fast enough it will explode. What occurs between the moment of initial impact and the time the explosion occurs continues to be a highly studied topic.

The team used hydrogen peroxide for the experiment. They demonstrated that 50 picoseconds (a picosecond is one trillionth of second) after the peroxide was shocked it begins to tear apart. The chemical bonds were completely broken by 100 picoseconds. The temperature increased by more than 1,500 degrees and the explosive pressure wave spiked to more than 200,000 atmospheres.

To read more, go to *Science Codex*.

theguardian **ELEMENT OF THE WEEK**

Lawrence Livemore and Russian scientists were the first to discover livermorium.

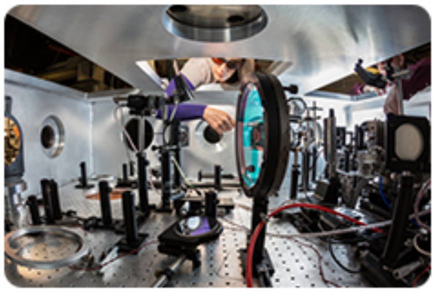
Livermorium, which has the atomic symbol, Lv**,** and atomic number, 116, is the last of the elements that has a permanent formal name (at this time). This element originally was given the temporary name, ununhexium (Uuh), and was formally named in 2012 for the Lawrence Livermore National Laboratory.

Lawrence Livermore and Dubna scientists first synthesized the element in 2000. They used a particle accelerator to fuse an atom of curium-248 with an atom of calcium-48. It took them one year -- and more than 2.3×10^{19} calcium ions -- to synthesize just one atom of livermorium.

Before it was named, livermorium was sometimes known as eka-polonium, because it occurs directly below that element on the periodic table. For this reason, it probably shares a lot of chemical properties with its little sister, and thus, it is viewed as a heavier homologue to polonium (a metalloid).

To read more, go to *The Guardian*.

R&D **SCIENCE ON THE TABLE**



LLNL researchers Felicie Albert (center) and Bradley Pollock (far right) prepare the Callisto laser system and setup for betatron X-ray experiments at the Lab's Jupiter Laser Facility.

A Lawrence Livermore team, along with researchers from the University of California, Los Angeles and SLAC National Accelerator Laboratory, has recently produced some of the highest energy betatron X-rays ever demonstrated, with the added benefit of being produced on a system the size of a large tabletop.

Betatron X-ray radiation, produced when relativistic electrons are accelerated and oscillate in a laser-driven plasma channel (during a process known as laser-wakefield acceleration), is an X-ray source holding great promise for future high energy density (HED) science experiments.

The experiments were performed at LLNL's Jupiter Laser Facility, using the 200-Terawatt Callisto laser system. By focusing Callisto's 60 femtosecond laser pulse onto a gas cell filled with helium, the researchers produced up to 80 kiloelectronvolts of betatron X-rays and measured for the first time the angular dependence of betatron X-ray spectra in a laser-wakefield accelerator.

To read more, go to *R&D Magazine*.

LIVERMORE LAB REPORT TAKES A BREAK

The *Livermore Lab Report* will take a break from Dec. 23-Jan 3 due to the Christmas and New Year's holidays. It will return Jan. 10.

LLNL applies and advances science and technology to help ensure national security and global stability. Through multi-disciplinary research and development, with particular expertise in high-energy-density physics, laser science, high-performance computing and science/engineering at the nanometer/subpicosecond scale, LLNL innovations improve security, meet energy and environmental needs and strengthen U.S. economic competitiveness. The Laboratory also partners with other research institutions, universities and industry to bring the full weight of the nation's science and technology community to bear on solving problems of national importance. To send input to the *Livermore Lab Report*, send e-mail